Funded by the European Union

DEL 02
Guideline how to design and create Hub/Demo class

EIT Manufacturing

Interactive Manufacturing @ Schools | March 2021 | Version: 1.0

eitmanufacturing.eu

Contents

1. Introduction 2
2. The idea of the Hub/Demo class 2
   2.1 Creativity 3
   2.2 Learning and problem solving 3
   2.3 Building and hands-on approach 4
3. How it should looks like? 4
   3.1. Interior design 4
   3.2. Partners, personnel and equipment of Hub/Demo class 5
   3.3. Activities of Hub/ Demo class 6
   3.4. Communication forum of Hub/Demo class 7
4. Learning tools 8
   4.1. Robots…. 8
   4.2. 3D printing machines 8
   4.3. Virtual/remote laboratories 10
5. Conclusions 10

1. Introduction

This deliverable is the report of the EIT Manufacturing's RIS Programme activity Interactive Manufacturing @ Schools (InMaS). In frame of our activity we set up specific goal to design and create Hub or Demo class as the place or platform through which activity leader and activity partners could cooperate with high schools and their pupils and teachers.

In 2021 InMaS edition a demo classroom's main purposes are to empower modern approaches to learning through robotics and give teachers example practices for their lessons. In a demo classroom, robots are not used as learning objects, but rather tools to learn with and develop skills. Robots could help students to better understand physics, math, chemistry and other STEM subjects.

From perspective of design or creation of such place or platform Hub or demo class should be a special place that nurtures creativity, learning, problem solving, building and hands on - all in one. Let's bring out creativity. Creativity has three key elements - playing, making and sharing …

2. The idea of the Hub/Demo class

The main objective for the design and creation of InMaS Hub/ Demo class, is to offer place or platform for systematical work and cooperation with high schools, their teachers and pupils. Through this Hub/Demo class we want to increase the involvement of pupils with engineering and manufacturing. The planned activities will focus on the development of a flexible didactical model under the concept of Industry 4.0 key enabling technologies. The activities aim at the delivery of content that is meaningful, comprehensive and attractive to pupils, in order to increase the interest and awareness of pupils in STEM, manufacturing and technical education.

It will be important to consider and develop a flexible structure of activities, capable of addressing the current COVID-19 remaining challenges. The primary objective will be to increase interactivity and hands-on experience by delivering most of the scheduled hubs/demo classes physically. Groups of pupils and teachers will attend LMS facilities and join the additional hub/demo class using the laboratory equipment. With the help of LMS personnel, the pupils will be gathered into groups and will be able to design and manufacture their own parts through advanced manufacturing processes such as Additive Manufacturing, CNC machining etc. In case that, due to COVID-19 protective measures, there will be no capability for the pupils to visit the laboratory facilities in a physical manner, the planned activities will be performed online and remotely.

2.1 Creativity

As we already mentioned above creativity has three key elements - playing, making and sharing. Sometimes we have forgotten the importance of playing, making and sharing.

Through play, we do feel alive in a way that is different from the feeling of being alive in ordinary life. It is a feeling that is open ended. It is a creative mindset by definition, because it is awareness of possibilities and of surprise outcomes: winning, losing, succeeding, resolving, affecting, surviving or failing to achieve. This is a source of an intrinsic pleasure, the pleasure of feeling more intensely alive than in ordinary life. It is driven by the deep pleasure of discovering new limits and new possibilities for self or for the group of affiliates. (Rochat, 2013). Human beings have existed in a complex creative relationship with tools for millions of years. When viewed in this broad historical framework, it is obviously the most natural thing in the world for human children/pupils to play with simple tools to make things. In doing so, they are engaging the most ancient and unique features of our special human mentality.

2.2 Learning and problem solving

In the beginning of creation of educational contet it is needed to set up clear learning objectives. After studying literature (R.M. Felder, R. Brent, 2016) on how to teach STEM education in practice we observed that well-written learning objectives enable instructors to achieve constructive alignment in a course.

- It is important to review the knowledge we want these pupils or even teachers to acquire and the skills we want them to improve in the learning provided by Hub. In the beginning of preparation of educational activities it is needed to write detailed learning objectives that address the targeted knowledge and skills.
- Design lectures, Hub´s learning activities, and assignments that illustrate and provide practice in all of the targeted skills, and create assignments and quizzes/exams that test pupils' mastery of the tasks specified in the learning objectives.
- In case you develop some STEM course with exam share the objectives with the pupils, ideally as study guides for exams and other course assessments. Continue to refer to them in your lessons and assignments.
- When the assessments show that many pupils are failing to meet an objective, consider modifying the corresponding lessons, activities, and assignments to provide more practice and feedback in the task(s) specified in that objective.

This process is iterative, usually taking several offerings of the course to arrive at satisfactory objectives, lessons, and assessments. It should be carried out again whenever the course content

is modified. Learning objectives may have any of three scopes: course-level objectives, individual lessons objective and section- level objectives.

For learning objectives to be effective, the actions they specify must be clear to the learners (pupils and STEM teachers) and observable by the instructor. For an objective to be considered clear, students should be able to read it and say with confidence, “Yes, I know what that means and I can do it” or “No, I can’t do that—and I’d better learn how before the exam.”

One of the main purposes of writing learning objectives is to communicate your expectations to the pupils. That purpose is defeated if the students can’t determine whether or not they can accomplish the specified tasks.

2.3 Building and hands-on approach

The other aspect of practicality will be based on gaining skills for building robots and using them for meeting learning goals. Building and hands-on approach means activities where pupils will build their robots or any other equipment for their assignments. It is important for them for building their practical skills and also gaining experience for their future more complex work.

3. How it should looks like?

This section will summarize there main aspects. The first is interior design or visual branding of InMaS of activity, but also due to requirements of EIT Manufacturing branding. The second is focused on processes, activities and services which will be covered and executed by Hub/Demo class. The third aspect describe shortly communication forum, because communication and dissemination of activities is important aspect of InMaS and also EIT Manufacturing activities.

3.1. Interior design

Demo classroom should look innovative, fresh, clean, forward thinking, interesting, playful and visually stimulating. It should be airy, easily and well adapted to pupils and to the needs for modern and interactive education. There is no need to rebuild good looking rooms because you can achieve modern learning design through following example elements like:

2.1 Big and inspirational pictures on the walls.
2.2 Posters – for example with explanatory notes for assignments.
2.3 Clothing that has printed pictures, elements or text on it.

2.4 Background walls.
2.5 Flyers.

Teachers should be able to share learning content to students on screens, project on walls or on TV-s. Things and all learning equipment should be fitted easily under tables or to special cupboards. Using boxes will make it easy to distribute equipment by type, experiment or any other classification needed. You could also use shelves.
A demo classroom will definitely need a challenge table - a place for students to test robots and for the teacher to explain tasks. Furniture in a demo classroom should be on wheels or easily movable. It will allow the teacher to make different setups based on the need of the topic or the number of students.
Having electricity sockets in the floor is crucial since loose extension cables on the floor will…. you know yourself.

Our goal is to create fresh and enchanting place / platform which will act as catalyst for increasing creativity and mutual learning, support cooperation and innovativeness. Overall it should be let's say synonymous for modern and interactive STEM education. For inspiration feel free to visit following link with video presentation:

https://drive.google.com/file/d/1IU91v7P94TG560uhJAX5X_5fBdAyljWi/view?usp=sharing

3.2. Partners, personnel and equipment of Hub/Demo class

For effective and smooth operation of our Hub/Demo class it is important to establish clear set of processes for it. Together with activity partners and our colleagues from universities we examined following operational model.

Hub partners – our partners will be high schools, their students from 2nd to 4th year of high schools and their teachers. Students who might be interested in engineering, programming and robotics. Teachers from secondary schools who specialize in programming, robotics and the use of robots and are interested in improving their knowledge and skills on how to work with pupils in these areas. There is also different group of partners like manufacturing companies and third parties and their representatives which can also provide valuable inputs and thoughts for pupils and teachers.

As Personal staff in HUB we identified that following personnel/positions are necessary for smooth execution of activities delivered by Hub / Demo class:

1. Leader of HUB – This person surveys the high schools and identifies those that are most suitable for collaboration, initiates contact with school officials/teachers and introduces them to hub initiative, responsible for communication with industrial partners and third parties interested in Hub activities

2. Educator / Teacher - Prepare and carry out teaching activities, responsible for the creation of the HUB program, on basis of the syllabus of the subjects prepares assignments, communicate with high school teachers and adapt the curricula and activities to pupils' needs, create learning nuggets, provides professional consultations to pupils, and evaluates the elaborated assignments and collect feedback
3. Digital platform support - deploys the e-learning platform (if not already in place), manages e-learning platform, trains educators in the use of e-learning platform, provides general technical support for platform and online tools, designs, develops, and integrates tools that are not a part of e-learning platforms by default
4. Technical support of HUB - person responsible for technical support and troubleshooting during laboratory practice, equipment service, prepares hands-on educational activities.
5. Communication leader of HUB – Executing the search for secondary schools for participation in Hub activities, prepare campaigns and promotion of Hub activities and events on the website, social media channels.

Technical equipment of HUB – it is necessary to ensure: robots – basic tool for vocational training, tablets, laptops for robot programming, whiteboard for projection and writing, projector, large TV.

HUB equipment - furniture - tables, chairs comfortable, easily movable according to the needs of the teacher. Shelves, cabinets, boxes for storing robots and the individual parts of which they are composed, a large "gaming" table for demonstrating and testing the work of robots. Electrical connection.

3.3. Activities of Hub/ Demo class

As mentioned in chapters above Hub / Demo class should execute several activities. Initially we have identified following activities:

1. Management of users - acquisition of secondary school, their pupils and teachers - on the basis of long-term cooperation with selected secondary schools, we will address these schools with an offer of their participation in Hub activities. In the first step, the selected high school students will be introduced to the project and our planned activities (webinar, workshop, possibly open days etc.). Subsequently, according to individual assignments, they will be involved in activities. In case of remote activities this specific requirement can be meet only by platform that has been designed directly for e-learning purposes, such as Google Classroom or preferably some Learning Management System (LMS).
2. Work with high schools - Hub will serves also like place where we want to offer teachers a space where they can meet and exchange their experiences of teaching specific subjects and involve various activities in the teaching process, in order to prepare pupils well for continuing their studies at university.

3. Hosting educational content; Multimedia and virtual lab integration – in this context, the educational content is any form of static or interactive learning material, such as e-books, presentations, learning nuggets, multimedia, virtual labs, tutorials, assignments, and quizzes. When solving the assigned tasks, pupils will work in groups (of 2-4 members) on assigned projects based on the syllabus of university subjects, taking into account their current knowledge and skills. Most of the file hosting and sharing platforms do not support all these forms of content at the same time, so we suggest using an LMS, which is directly designed for such purpose like Guided Learning Platform offered by EIT Manufacturing.
4. Creation of technical and knowledge background for a team of young technicians under the leadership of professionals in order to support participation of this group/team in national and international competitions in robot programming (for example First Lego League, or similar)
5. Running of communication platform with two levels of services. More description can be found in the following chapter 3.4.

3.4. Communication forum of Hub/Demo class

Communication this user or partners is very important aspect of activities of the Hub/Demo class. The forum serves two main purposes. Firstly, it is used for discussing the activities, their preparation, and scheduling between university and high school educators. Secondly it is used for interaction between teachers and students. For online real time form it is suggested to use one of available teleconferencing platforms like Google Meet or Microsoft Teams. For the forum with delayed responses, we can use either Google Chat, MS Teams, or a forum in Learning Management System.

We will regularly inform selected secondary schools, their students and teachers about current and new events that may concern not only to Hub, but also to the university/faculty as such. Hub will promote information about what is happening and the possibilities of participating in planned activities. As part of gaining a positive relationship with the university/activity partner, individual tours can be organized for participating secondary schools.

As part of Hub's activities, we also want to invite to cooperation industrial partners from manufacturing sector who would present their company and required skills of graduates for individual job positions.

One of the most important aspects of education is an evaluation of activities and learning feedback. It is important due to improving of quality of offered services and Hub overall. These can be done either manually by educators, which is time consuming, or automatically by learning platform. In LMSs could be all these features already incorporated and easy to use.

4. Learning tools

In frame of InMaS activity we decided to use three main learning tools for provide STEM education to pupils. These tools are following: Robots, 3D printing machines and virtual/remote laboratories.

"Children learn best when they are actively engaged in constructing something that has a personal meaning to them be it a poem, a robot, a sandcastle, or a computer program" [SEYMOUR AUBREY PAPERT]

4.1. Robots

Tools for learning are robots. It is up to personal and practical aspects what platforms teachers use. A demo classroom would also engage teachers from schools if they have similar equipment available back in school. Most common robotic platforms for education in current time are:

- LEGO Education Spike Prime and
- LEGO Mindstorms EV3 that could be used together with Vernier sensors.

But there are of course many other possibilities like Raspberry Pi with GoPiGo and Arduino, robotic arms etc.

A demo classroom should also include laptops or tablets for programming robots. You could store these in a deck or in a special cart that acts as a charging station.

4.2. Additive manufacturing and manufacturing processes

Planned activities will focus on engaging pupils to advanced manufacturing processes and novel technologies that have been briefly introduced through InMaS edition 2020 activities. The overall hub/demo class structure will be distinguished into theoretical and practical information sharing. The theoretical material is crucial for the methodological and efficient comprehension of the technical background and benefits.

The second task involves the delivery of more practical content and hands-on experience. The pupils will be directly involved with the technology that was presented in the first task of the hub/demo class, by using additional software and tools provided by LMS. The pupils grouped into teams will be capable of designing and developing their own parts with the help of experience

LMS personnel. Finally, they will have the chance to see their parts produced in real-time through advanced manufacturing processes, including Additive Manufacturing, CNC machining or assembly processes. The activities are planned to be performed in the laboratory facilities in order for the pupils to have access to the heavy equipment needed for the manufacturing processes. The pupils will have additional access to tools and hardware (PCs, design software etc.) to develop their own parts with the help of LMS personnel. Part manufacturing and assembly tasks will be performed in the laboratory machine shop, with the supervision of experienced engineers and in accordance to all protective measures to ensure pupil's safety within an environment consisted of heavy industrial equipment.

Figure 1 University of Patras - LMS facilities

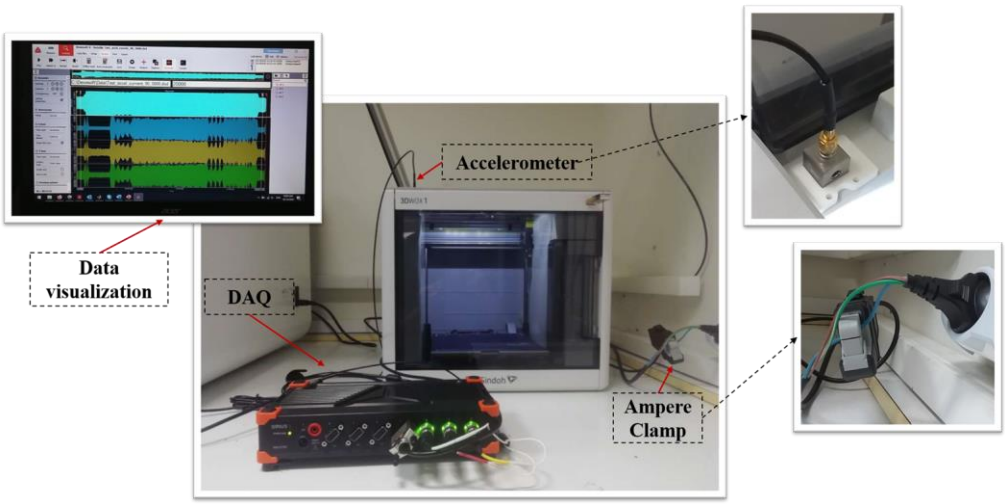

Figure 2 Additional University of Patras - LMS equipment considered for InMaS Hub/Demo class

4.3. Virtual/remote laboratories

The fast development of Internet technology and its increasing popularity has had an enormous impact on engineering. Through the implementation of InMaS activity we would like to show to our high schools teachers and pupils at least some basics of these technologies. It also facilitates the development of additional teaching strategies, including vivid and interactive ways of illustration, simulation, demonstration, experimentation, operation, communication, and so on. Laboratory experimentation play an essential role in engineering and scientific education and we are convinced that this can be valuable for high schools pupils.

5. Conclusions

Along with all previously mentioned aspects of a Hub/ Demo class, we can say that the most important key element is the teacher. For teaching you need much more than just things. A teacher is the key element for the learning process - creating narratives, telling stories, hypothesizing, helping with technicalities, helping to understand collected data and results, also making conclusions. The teacher should be able to keep students in flow - learning state where challenges and capabilities are matching.

Research shows that the experience of ‘flow’ is a very effective way of consolidating learning and ensuring that it is remembered, retrievable and transferable for the individual learner. When a learner experiences flow, the learner experiences that the challenges and tasks they engage with are challenging them to the right level of difficulty compared to their skill level. This allows learners to enter a state of mind where they can engage fully with the application of their skills and knowledge in an immersive, satisfactory manner, resulting in a feeling of being optimally challenged but also of being capable.

We tried to prepare this guideline to offer short summary of aspect which are important to consider when designing and creating such Hub/Demo class. We prepared this document as initial version of Guideline as comprehensive material summarizing all inputs received form activity partners and universities members. For now it is bit of desktop research with some practical experiences gained during previous work of activity partners and will be update during implementation of Interactive Manufacturing @ Schools activity. We hope that this guideline can be helpful for easy and effective replicability of this Hub / Demo class idea.